QUARTERLY FEED DEMAND FOR CORN

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This is a reprint of four articles that originally appeared in Feed Situation (FdS) reports in 1975 and 1976. These articles discuss feed demand for corn by quarters. The first article, for October-December 1975 appeared in FdS-259; January-March 1976, in FdS-260; April-June 1976, in FdS-261; and July-September 1976, in FdS-262.

OCTOBER-DECEMBER FEED DEMAND FOR CORN[1]

by

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ABSTRACT: Corn feeding is normally heaviest in October-December, the first quarter of the marketing year. Multiple regression analysis is used to measure the impacts of the factors affecting corn feed use during the first quarter. The analysis shows best results using price of corn, price of soybean meal, livestock output, and livestock prices as feed use determinants. As expected, higher corn prices reduce demand while higher livestock output and prices increase demand. The analysis also suggests that there is some substitution between soybean meal and corn. A projection for the October-December 1975 quarter is provided and areas for further quarterly analysis are outlined.

KEY WORDS: Corn, feed demand, feed-livestock prices, October-December quarter.

The following is an analysis of factors influencing domestic corn feed demand during the first (October-December) quarter of the feeding year. The ordinary least squares approach is used to relate first quarter use of corn for feed (QCDFl) to several explanatory variables for the period 1957-1974 (2).[2]

The quantity of corn fed to livestock in the first quarter of the marketing year has increased steadily since 1957, holding at a level above 1 billion bushels since 1966 (see table). It is normally the quarter of heaviest feeding during the season and from 1971 through 1974 accounted for more than one-third of total feed use in the marketing year. This compares with 29 percent for the 1961-64 period.

An analysis of first quarter demand can be helpful to commodity analysts in estimating the seasonal consumption pattern for a given supply of corn throughout the feeding year. Also, the important first quarter estimate of corn feed demand can serve as a benchmark for annual estimates of consumption.

The analysis based on the quarter relates total feed consumption of corn to aggregate variables for output of livestock (LO) and livestock prices (PL).

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[1]This is the first of a series of articles on quarterly feed demand for corn which will be published in the *Feed Situation*.

[2]Numbers in parentheses refer to references listed at the end of this article.

The correlation between the quantity of corn used for feed (mil. bu.) in the marketing year (QCDY) and the quantity of corn used for feed (mil. bu.) in the first quarter (QCDFl) is .95 for the historical period 1957/58 to 1974/75. This illustrates the importance of the October-December quarter in influencing annual feed use.

Of the equations tried, the linear equation below best reflects first quarter corn feed demand. The functional relationships are those normally associated with feed consumption. Numbers in parenthe-

$$QCDF1 = -73.5535 - (206.4039)PC + (33.2115)$$
$$PM + (375.3053) LO + (1.8897) PL$$

"t"	(4.38)	(1.08)	(4.83)	(2.91)
"e"	[−.25]	[.13]	[.64]	[.55]

$R^2 = .931$ S.E. = 67.47   D.W. = 1.76

sis below the equation coefficients are "t" statistics, a measure of statistical reliability of the coefficient. Bracketed terms are elasticities computed at mean values of variables. Explanatory variables are:

QCDF : Quantity of corn demanded for feed in Oct.-Dec., (mil. bu.)

PC : Average price received by farmers for corn in Oct.-Dec., ($/bu.)

PM : Price of soybean meal in Oct.-Dec., bulk Decatur, 44 percent, (cents/lb.)

LO : Production value of beef, pork and broilers,

(a constant price value aggregate) in Oct.-Dec., ($ bil., 1957-59 farm prices)

PL : Price received by farmers for livestock and livestock products in Oct.-Dec., (1910-14=100).

The signs of coefficients show that higher corn prices reduce quantity of feed demanded, while higher livestock output and prices increase the quantity demanded.

Beef cattle, hogs, and broilers are major factors shifting feed use from year to year, and these animals normally account for about two-thirds of corn feed use. Including eggs and milk in the livestock output aggregate (LO) failed to improve the results. The value aggregate for eggs and milk is high compared to the relative importance of layers and milk cows in total feed use of corn, which may explain why including these commodities did not improve the analysis. Soybean meal price (PM) also is a relatively weak determinant, but still suggests that there is some substitution between soybean meal and corn.

Quarterly Demand Is Slow To Respond

The direct price elasticity between use of corn and price of corn implies that a 10 percent increase in the price of corn will result in a 2.5 percent decline in feed use of corn. Thus, the equation implies that first quarter corn feed demand is not affected much by price changes in the short run.

Direct price elasticities from annual studies show more response than these first quarter results. Foote's annual analysis of the feed-livestock economy estimated a direct price response of -.47 with cross elasticities of .48 and 1.7 for livestock prices and quantities, respectively (1).[1] A later study by King estimated a direct price elasticity of -.74 where the price of corn was used as a proxy for all grain prices in a total feed demand equation (3). King estimated a cross price elasticity between feed demand and high protein price of .63. A recent study by Meilke suggests a direct price elasticity of -.44 for all feed grains (corn, sorghum, oats, and barley) and he concludes that high proteins substitute for feed grains with a cross elasticity of .24 (4).

The specification of our equation is similar to formulations in the related annual studies above. The lower elasticity found in the quarterly relationship is probably due to the constraint of time—a quarter versus a year. Producers tend to feed out to slaughter weights the animals they have in process even when they have losses on feeding. They may minimize their losses in this

way and adjust to unfavorable market conditions later by cutting back on feeding. On the other hand, if conditions call for more livestock output, there is a biological constraint to expansion.

Other Factors Did Not Help

Additional variables that might be expected to influence feed demand for corn are the prices of other feed grains, especially sorghum. However, sorghum price was statistically insignificant when included in the equations. Several reasons may be associated with this outcome, among which is the problem of strong collinearity or lack of independent variation between the price of corn and the price of sorghum. Changes in feed grain prices are practically indistinguishable from one grain price series to the other—movements are highly correlated. Another likely reason for insignificant results is the fact that livestock feeders often are accustomed to feeding rations containing feed common to their geographic region. Such a practice over the years could result in lower levels of substitution between the grains than might be expected from price relationships.

Both the general consumer price index and livestock price (PL) were used as general deflators of feed price variables in an attempt to use "real" prices. However, results were less favorable using deflated "real" prices. Use of fed beef rather than total beef production in the analysis also did not improve the estimating equation.

Estimating Feed Use for October-December 1975

Analyses for October-December feed demand provide tools and a consistency check for use in estimates prepared by feed, livestock, and soybean market analysts. Independent quarterly estimates for the variables PL, LO, and PM are used in the equation to provide a measure of overall impact on feed demand.

Likewise, similar equations in the livestock and soybean sectors can be applied such that consistent estimates are generated among these inter-related groups. To illustrate the use of the estimating equation, a projection for the October-December 1975 quarter was computed. The following values for independent (determining variables) were assumed for the quarter.

Farm price of corn, PC	= 2.90 ($/bu.)
Price of soybean meal, PM	= 7.00 (¢/lb.)
Price index for livestock and livestock products, PL	= 532 (1910—14=100)

The value aggregate for beef, pork, and broilers (LO) was computed using October-December 1957-59 average prices and October-December production forecasts as follows:

A cross elasticity of .48 between corn feed demand and livestock price implies that when livestock prices increase by 10 percent, corn feed demand will increase by 4.8 percent. Likewise a 10 percent increase in livestock quantity would result in a 17 percent increase in feed demand.

Corn: Quantity used for livestock feed and related variables, United States, 1957-74

Year beginning Oct. 1	Quantity of corn demand for feed Oct.-Dec. (QCDF1) Mil. bu.	Price received by farmers for corn Oct.-Dec. (PC) Dol. per bu.	Wholesale price of soybean meal Oct.-Dec. (PM) Cents per lb.	Value aggregate (1957-59 farm prices) of beef, pork, and broiler production Oct.-Dec. (LO) Bil. dol.	Price received by farmers for live-stock and livestock products, 1910 - 14 = 100 Oct.-Dec. (PL) Index	Quantity of corn demand for annual feed (QCDY) Mil. bu.
1957/58	745.6	1.01	2.26	1.331	255	2,533.8
1958/59	830.0	1.00	2.77	1.328	273	2,783.0
1959/60	871.6	.99	2.90	1.429	245	3,043.0
1960/61	854.2	.94	2.41	1.412	260	3,092.2
1961/62	953.6	1.00	2.92	1.484	252	3,212.5
1962/63	867.8	1.02	3.50	1.519	260	3,155.8
1963/64	810.0	1.08	3.75	1.648	242	3,008.9
1964/65	913.5	1.12	3.38	1.778	236	2,956.1
1965/66	915.4	1.09	3.63	1.728	280	3,361.2
1966/67	1,077.4	1.28	4.10	1.874	286	3,328.1
1967/68	1,094.5	1.02	3.62	1.893	273	3,508.2
1968/69	1,098.6	1.02	3.72	1.995	294	3,579.2
1969/70	1,140.7	1.09	3.80	2.031	335	3,796.3
1970/71	1,142.5	1.33	3.95	2.145	305	3,581.3
1971/72	1,355.0	1.02	3.82	2.126	332	3,977.8
1972/73	1,516.5	1.27	6.77	2.172	390	4,310.0
1973/74	1,462.8	2.25	8.64	2.140	507	4,193.0
1974/75	1/ 1,144.0	3.35	7.54	2.214	426	1/ 3,178.0

1/ Preliminary.

Item	Production	Prices	Value
	Mil. lbs.	Cents/lb.	$ Bil.
Beef	6,200	23.07	1.430
Pork	2,700	15.70	0.424
Broilers . . .	1,980	15.9	0.315
Total . . .	10,880	- - -	2.169

The livestock production aggregate (LO) totals $2.169 billion. This compares with $2.214 billion in October-December 1974. Using the above assumed values for variables in the analysis results in estimated feed use of 1,380 million bushels, a fifth above a year earlier.

Estimated values based on the equation track the historical feed use reasonably well (see figure), especially in the later period where corn use dropped substantially in the fall quarter of 1974. Thus, the estimate for this October-December 1975, should be in the neighborhood of actual feed use of corn if assumed values for independent variables—corn price (PC), meal price (PM), livestock price (PL), and livestock output (LO)—are about right for the quarter. Livestock output (LO) is considered by the authors to be the least firm number of the four variables estimated. This is due to possible changes in the proportion of fed beef relative to non-fed beef, which may cause output (at $2.2 billion in 1957-59 prices) to be a high side estimate. It is expected that fed cattle marketings will be rel-atively low in relation to total cattle slaughter for the current quarter compared to the historical period used in fitting the equation. For example, fed cattle made up 74 percent of the slaughter in October-December 1973 and 77 percent in 1972. This year we expect fed cattle to account for about 50-55 percent. Furthermore, the recent practice of placing heavier cattle on feed in order to reduce time in the feedlot is expected to continue during the quarter. These two factors suggest that estimated beef output for the quarter may be high and influence feed use accordingly.

Another consideration is the time required for producers to respond to the favorable feed and livestock price relationships. This response may be slower than usual and consequently feed demand may be less responsive (more inelastic) to price changes for the quarter. The livestock price index estimate is at a record level for October-December, about a fourth higher than last year. But most breeding decisions, for example, affecting June-August farrowings were made during February through April when the hog-corn price ratio was unfavorable for expanding production.

Although the equation appears to overstate feed use for the current quarter, the results definitely indicate a turnaround in corn feeding. This is supported also by visible indicators of feed demand.[4]

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[4]See discussion of feed demand, page 5.

DOMESTIC CORN FEED DEMAND, OCTOBER-DECEMBER QUARTER (QCDF1)
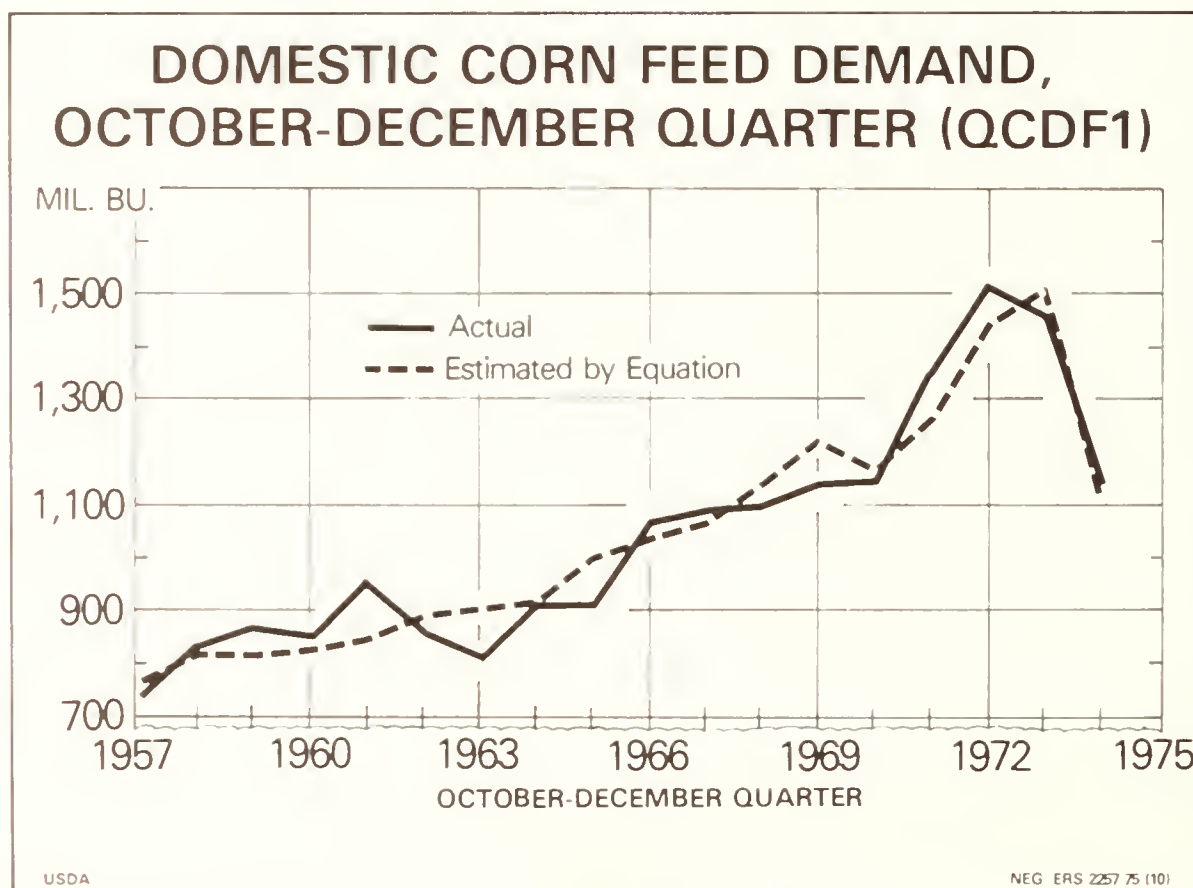
Further Investigation

Analyses such as the above article are never the final word. Rather they hopefully are a step in the direction of better understanding some of the forces underlying economic relationships in the feed demand for corn. This analysis is an aggregate investigation and as such requires that the livestock mix, as observed over the period in which the equation was estimated, remains essentially the same. Significant shifts in the mix could be expected to lead to biased estimates from the equation and would require a different approach in making a quarterly estimate. In this case a separate equation for each livestock group might be considered. Additionally, the nature of biological lags associated with production of livestock could be expected to influence current feed demand with different response from each major livestock group.

Finally, the above analysis constitutes only one part of the overall corn economy. It could be supplemented with equations which estimate exports, stocks, and food and seed use to complete the picture. Such a system could generate the complete supply and utilization system as well as market price.

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JANUARY-MARCH FEED DEMAND FOR CORN

by
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ABSTRACT: The second quarter of the corn marketing year (January-March) is normally a period of heavy feeding. Several multiple regression equations are used in determining those variables influencing corn feed use. Production decisions earlier in the marketing year by livestock and poultry producers apparently have a stronger influence on feed demand in the second quarter than in the first. Lagged livestock-corn prices show this influence. Livestock output and livestock prices in the current quarter are also important determinants of feed use. A projection for the January-March 1976 quarter is provided and special mention is made of the slow expansion in hog production.

KEYWORDS: Corn, feed demand, feed-livestock prices, January-March quarter.

This is the second in a series of articles examining factors that influence quarterly feed demand for corn. The least squares approach is used to relate corn feed use in the January-March quarter (QCDF2) to explanatory variables associated with the U.S. livestock industry.

Feed demand is normally strong in the January-March quarter of the marketing year, accounting for 25-30 percent of annual feed consumption and totaling about 1 billion bushels in 6 of the last 7 years.

Several equations were examined for their usefulness in capturing economic variables that significantly influence feed demand. In general, the first equation computed was equivalent to that used in the October-December quarter where current quarter livestock prices, livestock output, soybean meal price, and corn price were assumed to be demand shifters. These factors proved to be weak explanatory variables when applied in the second

quarter. This suggests that there may be lagging economic influences when livestock and poultry producers, responding to current or expected feeding conditions, adjust herd or flock size. These decisions set the stage for feed demand through time since, from an aggregate standpoint, a feeding period often is longer than one quarter. Therefore, current feed demand could be influenced by economic factors that took place several quarters back. The extent of this influence can be captured by lagged input-output prices.

The following equation, which incorporates this influence, is considered to be the "best" equation from the set of alternatives that were tried. Numbers in parentheses below the equation coefficients are "t" statistics, a measure of statistical reliability of the coefficients. Bracketed terms are elasticities computed at mean values of variables.

$$QCDF\ 2 = 124.36 + (.6402)\ PL + (1.3786)\ (PL/PC)*$$
$$+ (148.7391)\ LO + (142.4702)\ DCW$$

$$\begin{matrix} (2.09) & (3.10) \\ [.21] & [.36] \\ (1.97) & (1.94) \\ [.29] & [.008] \end{matrix}$$

$$R^2 = .79 \quad S.E. = 69.9 \quad D.W. = 1.60$$

Variable definitions are:

QCDF2: Quantity of corn fed in Jan.-Mar., (Mil. bu.)

PL: Index of prices received by farmers for livestock products in Jan.-Mar., (1910-14=100).

PC: Average price received by farmers for corn in quarter, ($/bu.).

(PL/PC)*: Average price ratio for the previous three quarters, i.e., $(PL/PC)^* = (PL_{-1}/PC_{-1} + PL_{-2}/PC_{-2} + PL_{-3}/PC_{-3})$ divided by 3.

LO: Production value of beef, pork, and broilers in Jan.-Mar., ($ bil., in 1957-59 farm prices).

DCW: Dummy variable for weather, where DCW = 1 in 1963, = 0 otherwise.

All coefficients in the equation are positive, indicating that current increases in livestock prices (PL) and livestock quantity (LO) will increase current feed demand. Likewise, a positive change in the lagged livestock-corn price ratio (PL/PC)* strengthens feed use. Thus, if in the previous three quarters livestock prices increase relative to corn prices, there will be more corn fed. DCW is included as a weather proxy to take into account unusually heavy feeding in 1963, when January temperatures in major livestock producing regions ranged from 1.5 to 2 standard deviations below average.[2]

Second quarter feed demand apparently is not very responsive to current feeding developments. Additional variables that showed weak or insignificant responses were current corn, sorghum, and soybean meal prices. The implication is that feeding decisions were made in previous quarters and, once set, producers will continue to feed out even if current conditions worsen.

The elasticity of .36 for the livestock corn ratio (PL/PC)* means that if this relationship increases by 10 percent, there will be a corresponding 3.6 percent increase in corn fed. Similarly, the livestock variables show considerably less influence than estimated in the fall quarter. If current livestock prices (PL) increase by 10 percent, this stimulates corn fed by about 2 percent, which is less than one-half the impact of this variable in the October-December quarter. Also, current livestock quantity (LO) has about one-half the estimated impact when compared with the fall quarter. If LO increases by 10 percent, this generates about a 3 percent increase in corn fed.

Approximately 80 percent of the variance is explained by the estimated relationship. In looking at this equation as a predictor, the figure shows

[2]See; U.S. Dept. of Commerce and U.S. Dept. of Agriculture, *Weekly Weather and Crop Bulletin*, Washington, D.C., Feb. 11, 1963, p. 7.

that the equation captured the large downturn in 1975. The largest error of estimate occurred in 1967 which was a high sorghum feeding year. However, overall results were not improved when the price of sorghum was used.

Estimating Feed Use for January-March 1976

To illustrate the use of the estimating equation, a projection for the January-March 1976 quarter was calculated. The following values for independent (determining) variables were used for the quarter:

Price index for livestock and livestock products, PL	= 500 (1910-14=100)
Lagged price ratio average, (PL/PC)*	= 188.6

The value aggregate for beef, pork, and broilers (LO) was calculated using January-March 1957-59 average prices and January-March production forecasts as follows:

Item	Production	1957-59 Prices	Value
	Mil. lbs.	*Cents/lb.*	*$ Bil.*
Beef	6,100	22.24	1.357
Pork	2,600	17.40	.452
Broilers . . .	2,015	18.80	.379
Total	10,715	- - -	2.188

For the January-March 1976 quarter, the estimated livestock production aggregate (LO) totals $2.188 billion, or less than 1 percent above the period a year earlier. Using the above values for explanatory variables the equation gives an estimated feed use of 1,030 million bushels or about one-eighth above a year earlier. Of course, the independent variables may be revised which could change the solution.
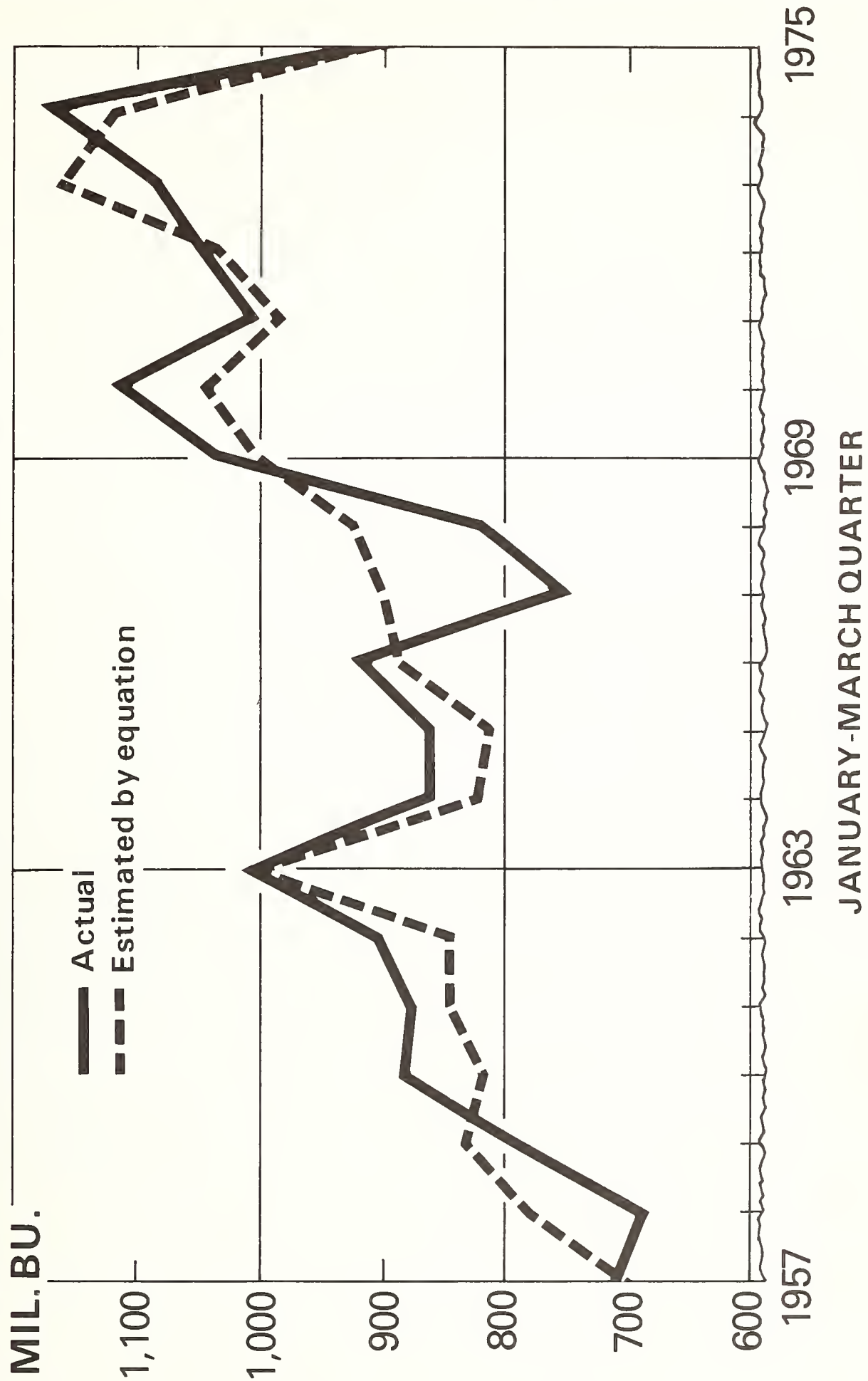
The results shown here should be considered in relation to other market conditions and indicators for feed demand discussed on page 5 of the *Feed Situation*. Hog production, which is now expanding due to very favorable profit margins, is an especially important consideration at this time. Hog producers indicated they intend to increase farrowings 8 percent during December-May. However, low inventory numbers are slowing the recovery in feed use by hogs. The December 1 inventory of hogs and pigs was placed at approximately 50 million head, which is 10 percent fewer than a year ago.

Corn: Quantity used for livestock feed and related variables, United States, 1956/57 to 1974/75

Year beginning Oct. 1	Quantity of corn demand for feed Jan.-Mar. (QCDF2) Mil. bu.	Price received by farmers for livestock and livestock products, 1910-14 = 100 Jan.-Mar. (PL) Index	Value aggregate (1957-59: farm prices) of beef, pork, and broiler production Jan.-Mar. (LO) Bil. dol.	Lagged livestock/corn price ratio (PL/PC)*	Quantity of corn demand for feed annual (QCDY) Mil. bu.
1956/57	710.3	231	1.343	170.1	2,378.3
1957/58	690.9	270	1.246	216.5	2,533.8
1958/59	792.5	267	1.324	248.1	2,783.0
1959/60	886.0	250	1.442	232.6	3,043.0
1960/61	879.2	261	1.436	246.3	3,092.2
1961/62	902.7	257	1.492	243.3	3,212.5
1962/63	1,000.0	251	1.566	246.3	3,155.8
1963/64	861.6	240	1.703	215.1	3,008.9
1964/65	864.2	239	1.728	204.9	2,956.1
1965/66	924.1	300	1.747	227.8	3,361.2
1966/67	757.7	277	1.918	228.8	3,328.1
1967/68	825.1	280	1.935	242.7	3,508.2
1968/69	1,037.8	304	2.004	280.9	3,579.2
1969/70	1,113.9	348	2.020	289.0	3,796.3
1970/71	1,007.9	316	2.139	250.0	3,581.3
1971/72	1,049.4	357	2.155	264.6	3,977.8
1972/73	1,088.4	454	2.115	314.5	4,310.0
1973/74	1,166.4	518	2.165	247.5	4,193.0
1974/75	912.7	421	2.172	143.5	3,178.0

DOMESTIC CORN FEED DEMAND,
JANUARY-MARCH QUARTER (QCDF 2)

MIL. BU.

Actual
Estimated by equation

1,100
1,000
900
800
700
600

1957
1963
1969
1975

JANUARY-MARCH QUARTER

USDA

NEG. ERS 2359-76 (1)

APRIL-JUNE FEED DEMAND FOR CORN

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ABSTRACT:: The third quarter of the corn marketing year (April-June) normally accounts for over one-fifth of the year's corn feed use. Multiple regression analysis is used in determining important variables influencing corn feed use. Lagged prices of livestock, corn, and soybean meal apparently are strong determinants of corn feed demand that reflect earlier decisions by livestock and poultry producers. Livestock output and corn prices in the current quarter also help to explain feed use. A projection for the April-June 1976 quarter indicates feed use will expand sharply from year-earlier levels.

KEYWORDS: Corn, feed demand, feed-livestock prices, April-June quarter.

This is the third in a series of articles examining factors that influence quarterly feed demand for corn.[1] The ordinary least squares approach is used to relate corn feed use in the April-June quarter (QCDF3) to explanatory variables associated with the U.S. livestock industry.

Feed demand in the April-June quarter of the marketing year has ranged between 21 and 24 percent of annual feed consumption since 1956/57. Except for the large cutback in 1975, April-June corn feed use has totaled well over 700 million bushels since 1966.

Several equations were examined for their usefulness in capturing economic variables that significantly influence feed demand. The demand equation selected is similar to the equation used for January-March. It appears that economic relationships several quarters back, when feeders traditionally make operational decisions for the year ahead, strongly influence April-June feed use. In other words, current feed demand is directly linked to decisions made by livestock and poultry producers in the previous three quarters. Lagged input-output prices, together with two current economic factors, best explain current levels of corn fed to livestock. Equation results are given below for the historical period 1956/57 to 1974/75. Numbers in parentheses below the equation coefficients are "t" statistics, and the bracketed terms are elasticities computed at mean values of variables.

$$QCDF3 = 222.78 - 165.1929 \; LO + .7628 \; (PL \cdot PC)^* + 51.5254 \; (PM)^* - 143.4153 \; PC$$

$$\begin{array}{cccc} (5.53) & (2.70) & (4.45) & (2.72) \\ [.42] & [.25] & [.29] & [-.26] \end{array}$$

$$R2 = .95 \qquad S.E. = 29.9 \qquad D.W. = 1.90$$

Robert Butell and Abner Womack, "October-December Feed Demand for Corn" *Feed Situation*, Economic Research Service, USDA, FdS-259, November 1975 and, same authors, "January-March Feed Demand for Corn," *Feed Situation*, Economic Research Service, USDA, FdS-260, February 1976. Related research references are contained in the bibliography of the first of these articles and will not be reproduced here.

Variable definitions are:

QCDF3: Quantity of corn fed in April-June (mil. bu.)

LO: Value of production of beef, pork, and broilers in April-June ($ bil., in 1957-59 farm prices).

PL: Index of prices received by farmers for livestock products in quarter (1910-14=100)

PC: Average price received by farmers for corn in April-June ($/bu.).

(PL/PC)*: Average price ratio for the previous three quarters, i.e., (PL/PC)* = (PL-1/PC-1 + PL-2/PC-2 + PL-3/PC-3) divided by 3.

(PM)*: Average price of soybean meal for the previous three quarters, bulk Decatur, 44 percent (cents/lb.).

The negative coefficient on current corn price shows that higher corn prices reduce the quantity of corn demanded for feed. On the other hand, increases in livestock quantity (LO) will increase current feed demand for corn. Also, a positive change in the lagged livestock-corn price ratio (PL/PC)* and the lagged price of soybean meal (PM)* strengthens feed use. Thus, if livestock prices increase relative to corn prices in the previous three quarters, apparently there is an incentive to feed more corn. Likewise, if the average price of soybean meal for the previous three quarters rises, more corn will be fed, with feeders making early commitments to substitute corn for meal.

Other economic variables examined to explain current utilization such as current prices for sorghum, soybean meal, and livestock generally showed weak or insignificant responses. Thus, feed demand in the third quarter seems to conform to estimated patterns for the first two quarters in that livestock producers tend to feed out existing herds once they are established.

The direct price elasticity between use of corn and the current price of corn implies that a 10-percent increase in price will result in a 2.6-percent decline in feed use. This is about the same response to current price changes as was found in the fall quarter. A 10-percent increase in the livestock/corn ratio (PL/PC)* will result in a corresponding 2.5-percent increase in corn fed. An increase of 10 percent in lagged soybean meal prices (PM)* causes a 2.9-percent increase in corn feeding. Value of current livestock output (LO) has the strongest impact of the variables selected. A 10-percent increase in LO generates about a 4-percent increase in corn fed.

The figure (on page 24) shows the change in April-June corn feed use from a smooth upward trend to a more erratic trend beginning in the mid-1960's. This reflects, among other things, the volatile movements in grain and livestock prices in recent years which are associated with reductions in world grain stocks and production. Approximately 95 percent of the variance is explained by the estimated relationship. Viewing this equation as a predictor and given the values of the determinants, the figure shows that the equation captured the large downturn in 1975 and tracks the historical period very well.

The largest errors for the equation occurred in 1966 and 1969. The underestimate in 1966 is apparently due to the 7-percent larger spring pig crop which was not yet fully reflected in LO. However, overall results were not improved when the spring (December-May) pig crop was used in the regression. In April-June 1969, a period of overestimate, crop quality may have been a factor. The grades of marketings of 1968 crop corn during and following harvest indicated the crop was of much better quality than in most years. This would tend to improve feeding efficiency and feed use would be lower than expected.[2]

Estimating Feed Use for April-June 1976

To illustrate the use of the equation, a projection for the April-June 1976 quarter was calculated. The following values for independent (determining) variables were used for the quarter:

$$(PL/PC)* = 199.0$$
$$(PM)* = 6.4 \ (¢/lb.)$$
$$(PC) = 2.50 \ (\$/bu.)$$

The value aggregate for beef, pork, and broilers (LO) was calculated using April-June 1957-59 average prices and April-June production forecasts for this year as follows:

Item	Production	1957-59 prices	Value
	Mil. lbs.	*Cents/lb.*	*$ Bil.*
Beef	6,200	23.74	1.472
Pork	2,800	17.99	.504
Broilers	2,265	18.60	.421
Total	11,265		2.397

The estimated livestock production aggregate (LO) for the April-June 1976 quarter totals $2.397 billion, or 7.6 percent above the period a year earlier. Greater livestock output together with a higher lagged livestock/corn price ratio and a lower current corn price indicate an expansion in April-June corn feed use in 1976 over the same quarter a year

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[2]See: *Feed Situation*, Economic Research Service, USDA, FdS-228, April 1969, p. 11.

Corn: Quantity used for livestock feed and related variables, United States, 1956/57 to 1975/76

Year beginning Oct. 1	Quantity of corn demand for feed April-June (QCDF3) Mil. bu.	Value aggregate (1957-59: farm prices) of beef, pork, and broiler production April-June (1.0) Bil. dol.	Lagged livestock/corn price ratio (PL/PC)*	Lagged wholesale price of soybean meal (PM)* Cents per lb.	Price received by farmers for corn April-June (PC) Dol. per bu.	Quantity of corn demand for feed annual (QCDFY) Mil. bu.
1956/57	509.9	1.352	180.1	2.43	1.22	2,378.3
1957/58	584.7	1.318	248.2	2.40	1.15	2,533.8
1958/59	624.9	1.429	255.6	2.93	1.15	2,783.0
1959/60	673.8	1.495	240.9	2.85	1.08	3,043.0
1960/61	693.4	1.595	256.8	2.67	1.01	3,092.2
1961/62	694.2	1.605	249.2	3.04	1.03	3,212.5
1962/63	697.9	1.691	244.1	3.57	1.12	3,155.8
1963/64	697.7	1.850	215.6	3.74	1.16	3,008.9
1964/65	665.4	1.754	206.5	3.39	1.25	2,956.1
1965/66	805.8	1.879	245.6	3.70	1.20	3,361.2
1966/67	769.1	2.017	221.9	4.26	1.26	3,328.1
1967/68	807.9	2.049	260.4	3.77	1.07	3,508.2
1968/69	745.1	2.066	286.4	3.82	1.16	3,579.2
1969/70	846.4	2.213	299.4	3.89	1.18	3,796.3
1970/71	771.9	2.298	232.9	4.00	1.41	3,581.3
1971/72	901.5	2.312	305.4	4.02	1.14	3,977.8
1972/73	962.6	2.140	320.5	7.35	1.67	4,310.0
1973/74	935.4	2.366	219.7	10.01	2.48	4,193.0
1974/75	679.0	2.227	136.8	6.94	2.67	3,187.0
1975/76	1/740.0	2/2.397	199.0	6.40	2/2.50	1/3,650.0

1/ Forecast. 2/ Estimated.

ago, despite a more competitive soybean meal price (see page 23). Using the above values for the explanatory variables, the equation gives an estimated feed use of 740 million bushels, about 9 percent above a year earlier. These results, of course, depend on the accuracy of our estimates of the current quarter price of corn and livestock output; however, all other variables in the estimating equation are known since they represent lagged influence.

The equation solution shown here should be considered in relation to other market conditions and indicators for feed demand shown on page 52 of the *Feed Situation.* Animal inventory numbers indicate an expansion in feed use is in process. The December 1975-February 1976 pig crop was 16 percent above the previous year. Hogs are major consumers of corn and these animals will be on full grain-protein rations in April-June. Cattle-on-feed inventories on April 1 in the 23 major cattle feeding States were up 28 percent from a year earlier. Broiler meat production is around 10 percent above year-earlier levels, while egg production has been up only about 1 percent. Despite this year's excellent quality crop, the sharp expansion in cattle on feed and increased hog numbers indicate that April-June feed use will likely be higher than the level shown by the equation results.
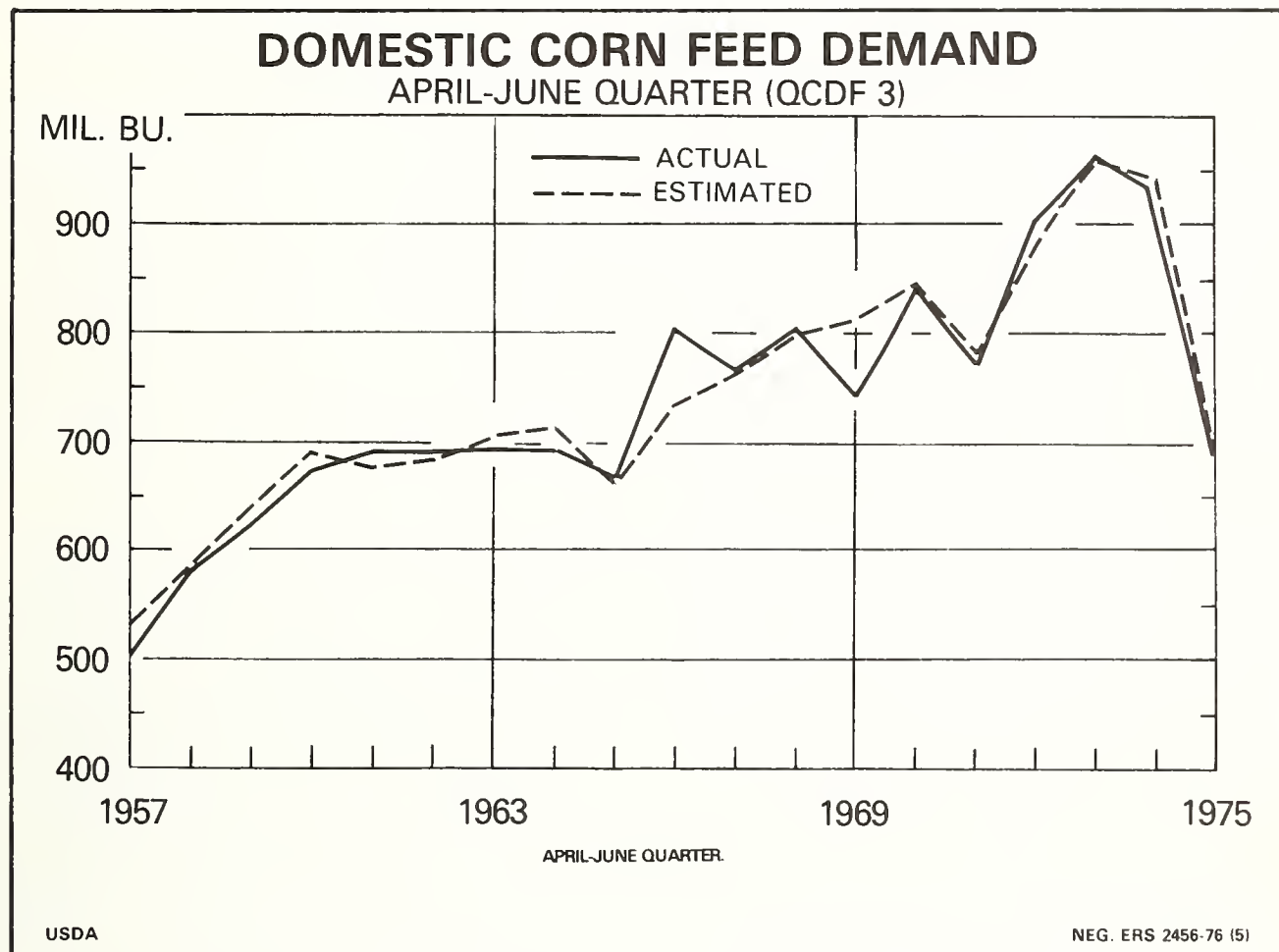
DOMESTIC CORN FEED DEMAND
APRIL-JUNE QUARTER (QCDF 3)

USDA

NEG. ERS 2456-76 (5)

JULY-SEPTEMBER FEED DEMAND FOR CORN[1]

by
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Commodity Economics Division

ABSTRACT: Corn feeding is normally lightest in the fourth quarter of the marketing year (July-September). Multiple regression analysis is used in determining important variables affecting corn feed use. In July-September, as in April-June, current feed demand is directly linked to lagged prices of livestock, corn, and soybean meal, which reflect earlier conditions in markets for livestock and poultry. Livestock output and corn prices in the current quarter also influence feed demand. The July-September quarter is somewhat unique in that wheat can directly compete with corn in many areas as a livestock feed due to wheat's usual seasonal low price at harvest when corn is typically at its seasonal high. Projected corn feeding in July-September 1976 is substantially above the 1975 level, which indicates a continuation of the expansion in feed use that began early in 1976.

KEYWORDS: Corn, feed demand, wheat feeding, feed-livestock prices, July-September quarter.

This article, the fourth in a series, examines factors that influence quarterly feed demand for corn.[2] The appraisal relates corn feed use in the July-September quarter (QCDF4) to explanatory variables associated with the U.S. livestock industry.

Since 1956-57, feed demand in the July-September quarter relative to annual consumption has ranged from over 22 percent in 1967/68 to just under 14 percent in 1974-75. Since 1966, July-September corn feed use has exceeded 600 million bushels except last year.

The equation in this report is similar to the one used for April-June except for the inclusion of the quantity of wheat fed. This is due to the fact that new crop wheat prices are often at a seasonal low, while corn prices are often at a seasonal high.

July-September feed demand is directly linked to decisions made by livestock and poultry producers in the previous three quarters. Three current factors are combined with lagged input-output prices in explaining current levels of corn fed to livestock. Statistical results are given below for the historical period 1956-57 to 1974-75. Numbers in parentheses below the equation coefficients are a measure of statistical reliability—"t" statistic for which a value of 2 to 3 suggests statistical reliability. The bracketed terms below the coefficients are elasticities computed at mean values of variables—which express each coefficient as a percentage change.

The analysis is based on the July-September quarter instead of the new June-September intra-marketing year period because actual historical data are not yet available for the new period. However, the same determinants of feed use would apply to the new period. In addition, the October-December quarter has been respecified in order to reflect the influence of lagged prices.

Robert Butell and Abner Womack, "October-December Feed Demand for Corn," *Feed Situation*, Economic Research Service, USDA, FdS-259, November 1975; "January-March Feed Demand for Corn," *Feed Situation*, Economic Research Service, USDA, FdS-260, February 1976; "April-June Feed Demand for Corn," *Feed Situation*, Economic Research Service, USDA, FdS-261, May 1976. Related research references are contained in the bibliography of the first of these articles.

$$QCDF4 = -254.91 + 379.5594LO + 30.5067(PM)*$$

$$\begin{array}{cc} (6.05) & (2.78) \\ [1.13] & [.20] \end{array}$$

$$-136.8392PC - 1.6858QWFED + 1.4161(PL/PC)*$$

$$\begin{array}{ccc} (3.57) & (4.50) & (3.83) \\ [-.31] & [-.17] & [.55] \end{array}$$

$$R^2 = .87 \quad\quad S.E. = 42.6 \quad\quad D.W. = 2.13$$

Variable definitions are:

QCDF4: Quantity of corn fed in July-September (mil. bu.).

LO: Measure of volume of production of beef, pork, and broilers in July-September (quantities weighted by 1957-59 farm prices, expressed in billion dollars).

(PM)*: Average price of soybean meal for the previous three quarters, bulk Decatur, 44 percent (cents/lb.).

PL: Index of prices received by farmers for livestock and livestock products in quarter (1910-14=100).

PC: Average price received by farmers for corn in July-September ($/bu.).

QWFED: Quantity of wheat fed in July-September (mil. bu.).

(PL/PC)*: Average livestock-corn price ratio for the previous three quarters.

Current corn price has a negative coefficient which implies that higher corn prices discourage corn feed use. In contrast, increases in value of livestock output (LO) will increase current feed demand for corn. Likewise, with an increase in the lagged livestock-corn price ratio (PL/PC)* and the lagged price of soybean meal (PM)* the quantity of corn fed increases. The livestock-corn price ratio in the current quarter did not improve the equation.

Wheat feeding is heaviest in the July-September quarter, when feed grain supplies are at their seasonal low while wheat supplies are largest because of new crop harvest. Neither the current price of wheat nor the price differential between wheat and corn satisfactorily captured the strong influence of wheat feeding in the feed demand equation for corn. These relationships suggest that a 10-percent increase in wheat fed leads to a decline of about 2 percent in corn feeding.

The current price for livestock proved to be insignificant, which suggests that current feeding is set to a large extent by placements or biological lags and leads. Current livestock output (LO) is an especially important variable in terms of its impact on feed consumption. A 10-percent increase in output of livestock products (LO) generates around an 11-percent increase in corn fed as might be expected.

The direct price elasticity of corn implies that a 10-percent increase in price will result in about a 3-percent decline in feed use. However, a 10-percent increase in the lagged livestock-corn price ratio (PL/PC)* for recent quarters would result in a corresponding 5- to 6-percent increase in corn fed. If lagged soybean meal prices (PM)* increase 10 percent, corn feeding would increase about 2 percent.

The determining variables used in this analysis explain about 87 percent of the variance in corn feed use during the period 1957 to 1975. Using actual values of the variables, the figure shows that the equation tracks well even for the large downturns in 1974 and 1975.

Estimating Feed Use for July-September 1976

To illustrate the use of the analytical framework, the July-September 1976 quarter was projected based on the best judgment available for the determining independent variables:

(PM) * = 6.8 (¢/lb.)
PC = 2.60 ($/bu.)
QWFED = 100 (mil. bu.)
(PL/PC)* = 201.7

The estimated livestock output aggregate (LO) suggests an output rate 10 percent above the same period in 1975. The production aggregate was calculated as follows:

Item	Production	1957-59 prices	Value
	Mil. lbs.	Cents/lb.	$ Bil.
Beef	6,400	23.52	1.505
Pork	2,900	17.94	.520
Broilers	2,330	17.80	.415
Total	11,630		2.440

Estimates based on the analysis indicate a sizable expansion in feed use of corn in July-September over a year earlier. A much higher lagged livestock-corn price ratio, a higher lagged soybean meal price, and a lower current corn price all suggest an expansion in corn feeding. On the other hand, the expected increase in wheat feeding this season, due to relatively low prices for wheat, would tend to offset a part of the gains suggested by other factors.

The analysis suggests estimated corn feed use of around 640 million bushels, or 45 percent above the very low feeding level in 1975. These results, of course, partly depend on the accuracy of the estimates of the price for corn, livestock output, and wheat fed. However, the other two lagged variables are known values.

This projection should be considered in relation to other market conditions and indicators for feed demand shown on page 5 of the *Feed Situation*. Animal inventory numbers generally support the level of July-September feed use shown by the equation results. Cattle on feed inventories on July 1 in the 23 major cattle feeding States were up 17 percent from a year earlier. The December 1975-May 1976 pig crop was 16 percent above last year's small pig crop. Broiler meat production is about 12 percent above year-earlier levels.

October-December Feed Demand For Corn Revisited

Results for the last three quarters of the October-September corn feeding year indicate that quarterly corn feeding is influenced by prices several quarters back when decisions are made by livestock producers in adjusting herd size. Once herd size is set, then feed use is largely a function of feeding rates and the biological feeding period.

The October-December analysis reported in the November 1975 *Feed Situation* specified only current economic variables.[1] While the forecasting equation tracked well historically, it did poorly in 1975. Very favorable livestock-feed price relationships for feeding had been tempered by extremely poor feeding conditions in 1974 and early in 1975. There was also a dramatic shift from fed to nonfed beef. Consequently, the authors have respecified the equation to include a lagged price ratio and fed beef production instead of total beef production.

The equation given below supersedes the equation published in November 1975. Numbers in parentheses are "t" statistics, bracketed terms are

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Robert Butell and Abner Womack, "October-December Feed Demand for Corn" *Feed Situation*, Economic Research Service, USDA, FdS-259, November 1975.

elasticities computed at mean values of the variables.

$$\text{QCDF1} = -155.96 + .7477 \ (PL/PC)^* + 364.2846 \ LO$$

$$(1.31) \qquad\qquad (4.54)$$
$$[.17] \qquad\qquad [.50]$$

$$+ \ .9630 \ PL + 111.2436 \ (PM/PC)$$

$$(3.94) \qquad (1.72)$$
$$[.29] \qquad [.19]$$

$$R^2 = .93 \qquad\qquad \text{S.E.} = 64.5 \qquad\qquad \text{D.W.} = 1.71$$

Variable definitions are:

QCDF1: Quantity of corn fed in October-December (mil. bu.).

LO: Measure of volume of production of fed beef, pork, and broilers in October-December (quantities weighted by 1957-59 farm prices, expressed in billion dollars).

PL: Index of prices received by farmers for livestock and livestock products in October-December (1910-14 = 100).

PM: Average price of soybean meal in October-December, bulk Decatur, 44 percent (cents/lb.).

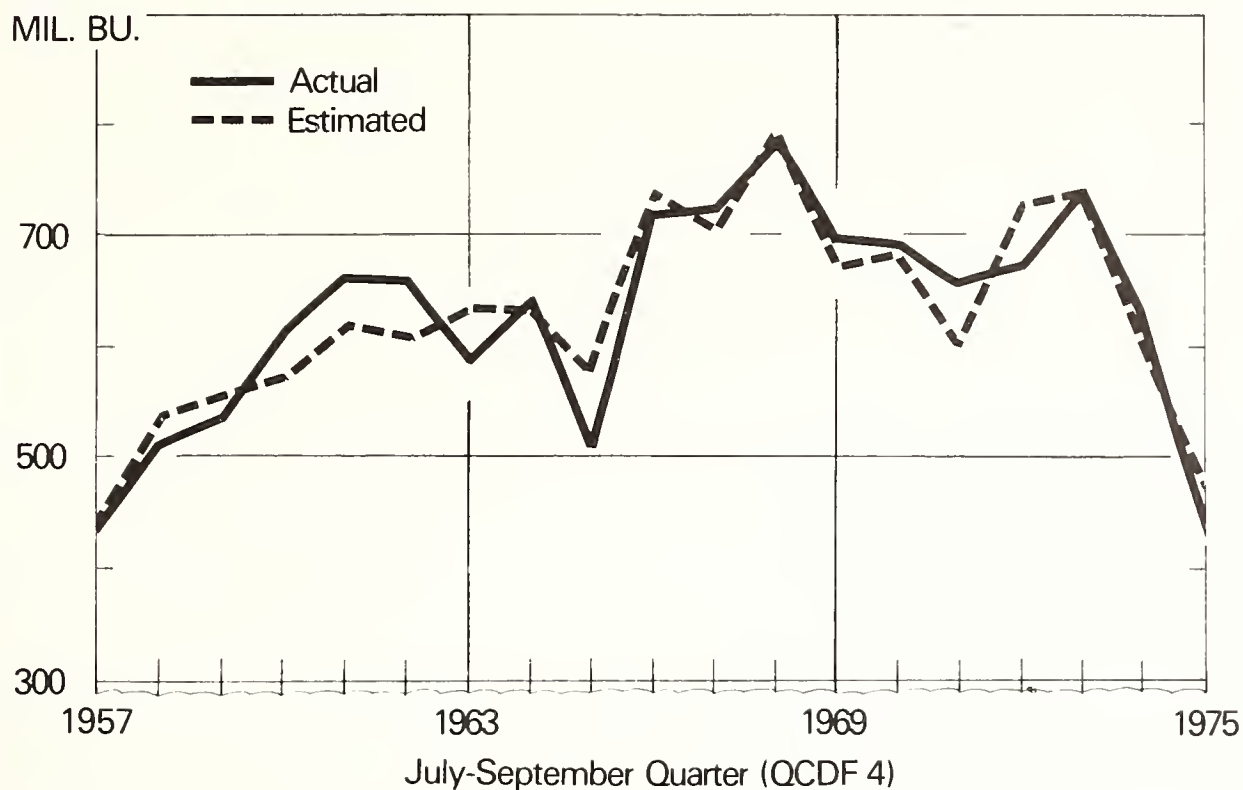PC: Average price received by farmers for corn in quarter ($/bu.).

(PL/PC)*: Average livestock-corn price ratio for the previous three quarters.

PM/PC: Average price ratio in October-December (lb. for lb. basis).

Forecasts for independent (explanatory) variables are provided for the October-December 1976 quarter (see table 2). Greater livestock output, a higher lagged livestock/corn price ratio, and a higher soybean meal/corn price ratio all indicate an expansion in October-December corn feed use in 1976 over 1975. However, this expansion is tempered by lower expected prices for livestock. Using the values shown, the equation gives an estimated feed use of 1,310 million bushels, about 16 percent above the low level of a year ago.

DOMESTIC CORN FEED DEMAND

MIL. BU.

— Actual
-- Estimated

700

500

300

1957　　　　　1963　　　　　1969　　　　　1975

July-September Quarter (QCDF 4)

USDA　　　　　　　　　　　　　　　　NEG. ERS 2516-76 (7)

DOMESTIC·CORN FEED DEMAND

MIL. BU.

1,500

Actual

1,300

1,100

Estimated by Equation

900

700

1957　　1960　　1963　　1966　　1969　　1972　　1975

OCTOBER-DECEMBER QUARTER (QCDF 1)
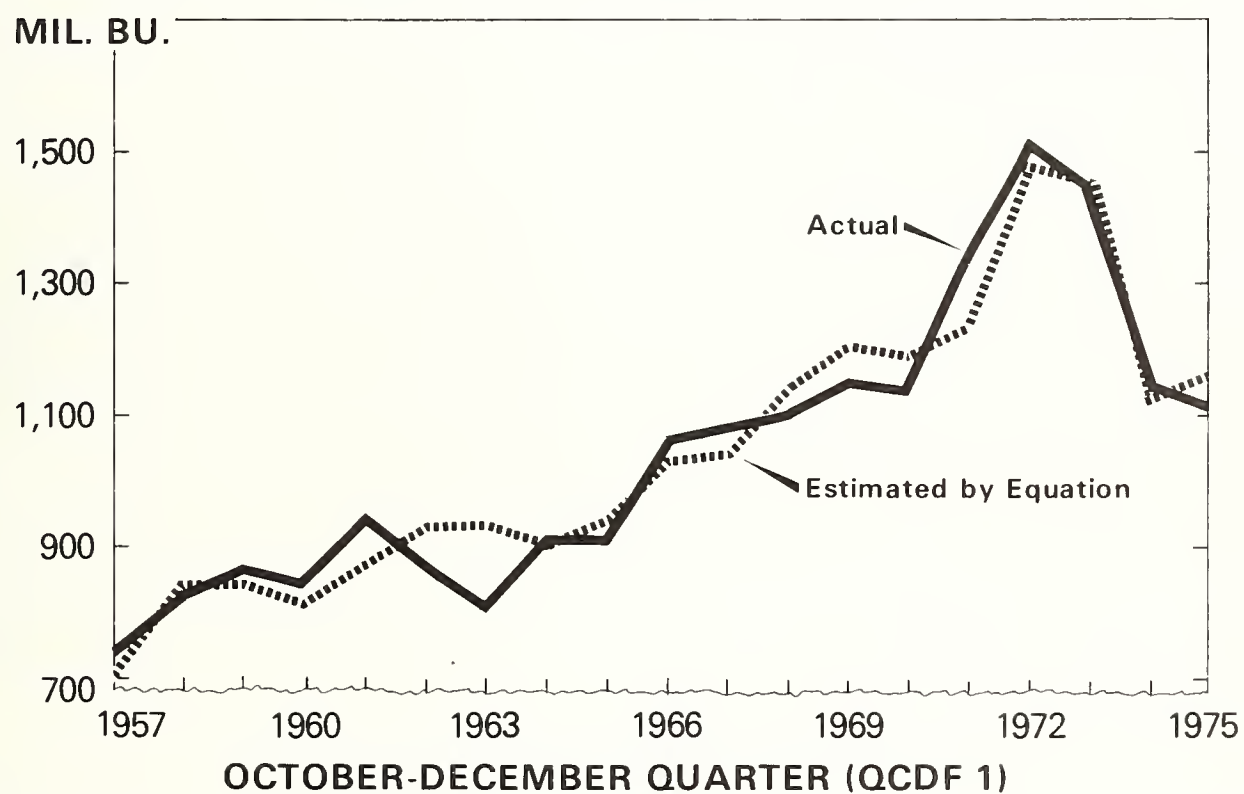
USDA　　　　　　　　　　　　　　　　NEG. ERS 2565-76 (8)

Table 1.--Corn: Quantity used for livestock feed in the July-September Quarter and related variables, United States, 1956/57 to 1975/76

Year beginning Oct. 1	Quantity of corn demand for feed July-Sept. (QCDF)	Value aggregate (1967=59): farm prices of beef, pork, and broiler production July-Sept. (La)	Lagged livestock/ corn price ratio (Pl/PC)*	Lagged wholesale price of soybean meal (Pl)*	Price received by farmers for corn July-Sept. (PC)	Quantity of wheat fed to livestock July-Sept. (QWFED)	Quantity of corn demand for feed annual (QCDFY)
	Mil. bu.	Bil. dol.		Cents per lb.	Dol. per bu.	Mil. bu.	Mil. bu.
1956/57	437.9	1.366	190.9	2.3?	1.20	0	2,378.3
1957/58	512.6	1.369	253.3	2.51	1.16	5	2,533.8
1958/59	535.5	1.636	251.3	2.81	1.12	15	2,783.0
1959/60	611.7	1.507	243.1	2.84	1.07	16	3,043.0
1960/61	665.5	1.549	259.4	2.97	1.04	18	3,092.2
1961/62	661.9	1.545	248.6	3.04	1.04	14	3,212.5
1962/63	590.1	1.668	232.9	3.52	1.20	10	3,155.8
1963/64	639.7	1.769	211.4	3.63	1.14	20	3,008.9
1964/65	513.0	1.806	204.4	3.46	1.19	50	2,956.1
1965/66	715.9	1.918	247.9	3.85	1.32	15	3,361.2
1966/67	723.9	1.971	218.4	3.94	1.15	35	3,328.1
1967/68	780.7	2.272	264.7	3.73	1.01	100	3,508.2
1968/69	697.6	2.101	280.3	3.68	1.17	128	3,579.2
1969/70	695.3	2.173	295.7	3.85	1.30	140	3,796.3
1970/71	659.0	2.270	225.0	3.92	1.22	164	3,581.3
1971/72	671.9	2.215	323.9	4.29	1.17	170	3,977.8
1972/73	743.9	2.031	310.0	10.80	2.29	136	4,310.0
1973/74	631.7	2.301	197.7	7.36	3.19	53	4,193.0
1974/75	444.1	2.219	148.6	6.54	2.81	80	3,191.0
1975/76 1/	640.0	2.440	201.7	6.80	2.60	100	3,650.0

1/ Forecast.

Table 2.--Corn: Quantity used for livestock feed in October-December quarter and related variables, United States, 1957/58 to 1976/77

Year beginning Oct. 1	Quantity of corn demand for feed Oct.-Dec. (QCDF1) Mil. bu.	Value aggregate (1957-59 farm prices) of fed beef, pork, and broiler production Oct.-Dec. (LO) Bil. dol.	Lagged livestock/corn price ratio (PL/PC)*	Price received by farmers for livestock and livestock products, 1910 - 14 = 100 Oct.-Dec. (PL) Index	Soybean meal/corn price ratio Oct.-Dec. (PM/PC)
1957/58	746	.923	198.4	255	1.26
1958/59	830	1.015	252.2	273	1.55
1959/60	872	1.105	236.2	245	1.64
1960/61	854	1.071	238.2	260	1.43
1961/62	954	1.162	246.7	252	1.63
1962/63	868	1.215	247.0	260	1.92
1963/64	810	1.328	217.3	242	1.94
1964/65	913	1.360	206.5	236	1.69
1965/66	914	1.303	209.5	277	1.86
1966/67	1,077	1.487	237.2	283	1.79
1967/68	1,096	1.532	226.4	270	1.99
1968/69	1,106	1.607	273.5	291	2.04
1969/70	1,149	1.707	279.5	331	1.95
1970/71	1,144	1.832	277.0	303	1.66
1971/72	1,355	1.828	237.6	333	2.10
1972/73	1,512	1.885	323.3	390	2.98
1973/74	1,458	1.846	289.4	506	2.15
1974/75	1,148	1.681	168.5	425	1.26
1975/76	1,130	1.511	166.1	508	1.42
1976/77 1/	1,310	1.718	190.2	480	2.20

1/ Forecast.

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C. 20250

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